MYCOLOGIA

VOL. XV JULY, 1923 No. 4

OCCURRENCE AND IDENTITY OF COTTON MILL FUNGI

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(WITH PLATE 16)

A previous paper of the writer's (8) dealt with studies upon the physiology of five structural timber-destroying fungi important in the decay of cotton mill weave shed roofs. The present paper gives further observations upon the occurrence of fungi within cotton mills and upon the identity of those which are primary agents in the decay of the mill timbers, with additional notes on the cultural characters of certain of them.

MYXOMYCETES

It is to be expected that myxomycetes should be found in the weave sheds and dye houses of cotton mills where the humidity is high. *Fuligo ovata* (Schaeff.) Macbr. has often been found both on badly decayed wood, which was quite moist, and the painted surfaces of apparently sound wood. Of much more common occurrence, however, is *Stemonitis fusca* (Roth) Rost. This plant has been collected upon newly built roofs and basement ceilings, old roofs, and upon newly painted roofs. In one new warehouse not quite finished this species of *Stemonitis* occurred in large quantities on the ceiling of the basement and four floors above it. It grew mostly in the angles between the beams and the flooring, in hundreds of clusters, some of which were several inches long. The presence of so much growth in a structure not quite finished

[MYCOLOGIA for May (15: 107–151) appeared May 31, 1923]

was the cause of no little concern to the contractor, who knew only that " fungus " caused him much loss and trouble.

Another myxomycete of rather rare occurrence anywhere, *Reticularia lycoperdon* Bull.,[1] was found on the roof of one weave shed. The fructifications occurred literally by hundreds on the yellow pine rafters and roof planks, most commonly in the angles between the two. The ashy gray, more or less globular fruit bodies were not very conspicuous against the dusty white paint, but where the peridia of old ones had disappeared there was a dark brown blotch made by the spores. These peridia are very delicate and when they are broken the brown spores drop out in spoonsful, like cocoa. One interesting fact in connection with the occurrence of these plants was that they were found only upon one half of the weave shed roof. The shed was about 300 feet wide, pitched in the middle with the drains at either side. The pitch ran north and south parallel to a body of water to the east. This myxomycete occurred only on the west half. It would seem that this half of the roof must have been the moister of the two, but what factor made it moister than the east half was not determined.

PENIOPHORA

Two species of *Peniophora* are collected occasionally in mills. *P. pubera* (Fr.) Sacc.[2] is found on badly decayed wood and usually on wood that is very moist, even dripping with water. Out of doors it is usually found upon frondose wood, but it occurs on spruce and hard pine in mills.

Peniophora gigantea (Fr.) Mass [3] has thus far been seen more particularly on hard pine beams in cotton warehouses. It is very common in old warehouses and has been found in new ones upon hard pine sapwood that was discolored from long storage out of doors. Timbers showing this fungus have probably always become infected in storage. In one warehouse in particular, the basement of which had been flooded all summer, nearly every beam was infected with this fungus, some of the patches being several

[1] This plant was identified by Dr. C. G. Lloyd.

[2] The writer is grateful to Dr. E. A. Burt for the identification of this fungus.

[3] The identification was confirmed by Dr. Burt.

square feet in area. The contractor was just completing the structure and was much worried at the appearance of this extensive growth.

CONIOPHORA CEREBELLA Pers. and MERULIUS LACRYMANS Wulf. ex Fr.

Coniophora cerebella Pers. has been found occasionally in mills, either in basements or on upper floors, but not thus far on weave shed roof planks, where conditions are apparently not favorable for its growth and reproduction. That this factor is not temperature seems probable, because the optimum for the species is 26° C. and the inhibiting point 36° C.—only a little lower than the same points for any of the fungi which do grow on weave shed roof planks. It is possible that the factor may be moisture, because it has been noted in flask cultures that most of the growth of *C. cerebella* occurs in the upper half of the flask, which is, of course, drier, and almost none in the lower or moist half.

A species of *Merulius* determined, where determination was possible, to be *M. lacrymans* Wulf. ex Fr. has been found quite often in similar locations and especially in cotton ware- and storehouses. It is very destructive to floorings near the ground and beams resting upon masonry. It is also found often in the wood work around valve pits, where during the summer a great deal of moisture is present. Strands and mycelial mats have been found in some cases covering several square yards of brick work in such places, spreading to all the near-by wood material. It has also got into baled cotton occasionally and rotted the cotton on the ends of the bales quite extensively. The mycelium, at first white, turns yellow in the latter part of the summer and forms fruiting surfaces during the latter part of September and in October.

LENZITES SEPIARIA Fr.

The importance of this fungus in the decay of mill roofs has not been properly emphasized. The opinion was some time ago expressed by F. J. Hoxie that *L. sepiaria* Fr. and *L. trabea* Pers. ex Fr. were responsible for the greater part of the decay of cotton mill roofs. It certainly appears as if this were true, for some of

the other fungi responsible for the more spectacular and better known instances of decay are of much rarer occurrence. A good number of the more ordinary cases of roof decay are caused by *L. sepiaria*. Sporophores of this fungus occur quite commonly on mill roofs, growing in the cracks between the planks. They are formed from spring to fall, but not during the winter. While the temperature within the mills is high all the year around, the roof itself is cool enough in the winter time to prevent fructification. The sporophores are usually not pileate, but occasionally so, and are normal in color for the species. The hymenium may be lamellate, daedaloid or poroid, or irpiciform if growing in too wet wood. The spores are quite often smaller than those from fruit bodies collected out of doors. They have been found to measure 6–9 x 2.5–3 μ (mostly 6–7 x 3 μ) as against 8–12 x 2.5–4 μ given by most mycologists.

The cultures of the various isolations of this fungus vary. The first one used (8, pp. 19 and 22) produced either a sodden growth with no superficial mycelium or only a meager superficial growth. On wood it grew in a similar manner, developing little superficial mycelium which formed oidia. Another culture of *L. sepiaria* obtained from spores collected in a mill grew differently. On agar [4] it has occasionally produced the sodden growth, but more often a thick development of superficial mycelium. On wood it has produced an abundant superficial growth with large wads of mycelium which is at first white and may become the characteristic sepia color. On the walls of the flasks a concentric growth often appears.

LENZITES TRABEA Pers. ex Fr.

Lenzites trabea is of more common occurrence in mills than has been supposed (8, p. 4), the writer having thus far found it nearly as often as *L. sepiaria*. *L. trabea* is normally thought of as growing on hardwoods, although it is known to occur on both hardwoods and conifers as does *L. sepiaria*. The writer has found both species side by side on both poplar and pitch pine pulp bolts. On mill roofs it has thus far been collected only on spruce.

Some flask tests were run to test the ability of *L. trabea* to attack

[4] 3 per cent agar, 2½ per cent malt, + 8 Fuller scale—not adjusted.

various conifers and hardwoods, in comparison with other species of fungi, more particularly *L. sepiaria.* The methods were those described by Humphrey (5). These tests (Table I) showed that *L. trabea* was in no wise inferior to *L. sepiaria* and the other mill roof fungi in decaying coniferous woods, but that it did decay the hardwoods somewhat more readily even than *L. sepiaria,* which is very destructive to these woods under the test conditions.

TABLE I

COMPARISON OF THE ABILITIES OF *Lenzites trabea* AND *L. sepiaria* TO ATTACK WOODS OF CERTAIN CONIFEROUS AND HARDWOOD TREES, AS INDICATED BY PERCENTAGE LOSS OF OVEN DRY WEIGHT AFTER ONE YEAR OF INCUBATION AT ROOM TEMPERATURE

	Lenzites sepiaria, per cent	*Lenzites trabea*, per cent
Cypress (*Taxodium distichum*)	50	43
Port Orford cedar (*Chamaecyparis lawsoniana*)	6	6
Southern yellow pine (*Pinus palustris*)	26	7
Douglas fir (*Pseudotsuga taxifolia*)	13	18
Western yellow pine sapwood (*Pinus ponderosa*)	33	38
Sitka spruce (*Picea sitchensis*)	50	50
Eastern white pine (*Pinus strobus*)	32	25
White oak (*Quercus alba*)	1	3
Chestnut (*Castanea dentata*)	4	12
Norway maple (*Acer pseudoplatanus*)	46	70
Redgum (*Liquidambar styraciflua*)	43	54
Basswood (*Tilia americana*)	28	50
Yellow poplar (*Liriodendron tulipifera*)	45	52

The sporophores of *L. trabea* in mills occur in much the same manner as do those of *L. sepiaria.* They have the color normal to out-of-doors specimens and the same characteristic daedaloid hymenium for the most part, although abortive forms occur on very wet wood. The spores measure 7–8 x 2.5–4 μ. The cultures of *L. trabea* have already been described (*loc. cit.*), being characterized by both oidia and chlamydospores and a light ochraceous buff color when mature or when immature if taken from decayed wood.

Lenzites trabea fruits in mills at the same time as does *L. sepiaria.* The two species can readily be distinguished by their sporophores and by their cultures.

TRAMETES SERIALIS Fr.

Exact statements as to the occurrence and identity of *Trametes serialis* Fr. are difficult to make at the present time. In the first place, the limits of the species are variously interpreted by mycologists. In the second place, within mills there are so many abnormal fungus growths, most of them white, that it is difficult to say how much of the decay is due to *T. serialis* under any interpretation of the species. These growths vary from the thin resupinate fructifications of *T. serialis* to large rounded masses with or without pores. These latter forms are white, farinaceous, and have a bitter quinine taste. These characters immediately suggest *Fomes officinalis* Vill. (*F. laricis* Jacq.), but typical *Trametes serialis* has the same appearance and taste. The writer has been able to get the quinine taste from nearly all the specimens of *T. serialis* tested. If *Fomes officinalis* does occur in mills, it is the only one of the important heart rotting fungi to be found fruiting within buildings. The matter can readily be tested by cultures, as cultures of the two fungi are entirely different (Faull, 3, and Snell, 8, pp. 20 and 23).

Trametes serialis occurs more often in moist basements than upon weave shed roofs, although two cases of severe decay have recently been proved definitely to be caused by this species.[5] Plate 16 shows fruit bodies collected in one of the mills in early June, 1921.

TRAMETES CARNEA Nees ex Cooke

In a previous paper (*loc. cit.*) the species here treated was called *Fomes roseus* Alb. & Sch. ex Cooke. There is still some difference of opinion as to the validity of *Trametes carnea* as a species distinct from the former, but some data recently obtained by the writer and about to be published give him reason to believe that the distinction is valid. At all events, the cultures described and used previously were obtained from the thin annual form and not the thick woody perennial form. This fact should be borne in mind. In the bulletin referred to, then (8), the writer would change *Fomes roseus* to *Trametes carnea.*

Neither *Fomes roseus* nor *Trametes carnea* has to the writer's

[5] The identification of the fungus was confirmed by Dr. L. O. Overholts.

knowledge been found inside a weave shed. A form with a pink hymenium has been found on the outside in moist places, such as under eaves, on the ends of rafters and beams, etc., and in moist basements. Whether this fungus is *Fomes roseus* or *Trametes carnea* is not definitely known. Many of the forms found on the under side of rafters and planks were apileate and it was difficult to determine to which species they belonged. Those forms that the writer has seen have been round for the most part (8, pl. II, fig. 5), with a definite lip and quite thick, and because of a similarity between these and forms found on structural timbers elsewhere, which could be definitely determined, the writer would incline to the belief that most of the forms in mills belong to *Fomes roseus*. *Trametes carnea* in similar positions does not form rounded fructifications, but linear ones, and it has no definite lip.

If the species is *Fomes roseus*, as the meager evidence available at present seems to show, it should be emphasized that this fact does not in any way controvert other evidence possessed by the writer and about to be published, relative to different moisture requirements at least, for the fructification of the two species.

The differences between various isolations of *Trametes carnea* and *Fomes roseus* in culture have already been pointed out. In the paper referred to (pp. 20, *et seq.*) one type of *T. carnea* was described. Recently another culture has been used and is much different. It shows very little of the initial soft white mycelial growth and soon forms the tough matted rose-colored tertiary mycelium on both agar and wood. This colored tertiary mycelium does not infect wood very readily, if at all. The delicate white (or secondary) mycelium spreads rapidly from block to block, but the tertiary mycelium apparently has other functions. Inoculation of wood can not be made with the colored mycelium from agar cultures, nor will a block covered with this colored mycelium infect another uninfected block placed beside it. Old wood cultures of the first type remained white and never fruited. The more recent one becomes the characteristic "roseus" color very soon and forms fruit bodies, for the most part apileate, upon agar and the wood blocks.

LENTINUS LEPIDEUS Fr. AND LENTINUS TIGRINUS Fr.

Lentinus lepideus Fr. and *L. tigrinus* Fr. have both been reported as destructive to mill roofs (8 and 1, respectively). Both of these species may perhaps occur in mills, but all the material examined by the writer has without any doubt been *L. lepideus*. This includes abundant material from Massachusetts mills in one of which one of the most spectacular cases of rot has thus far occurred. In this mill, sheathing on the under side of the rafters formed a series of moist chambers under the entire roof. The roof began to decay after seven years and the sheathing was then removed. Inside were found many abortive fruit bodies of the type formed by *Lentinus lepideus* in the dark (Buller, 2, *et. al.*) and fructifications of the resupinate *Trametes serialis* types. After the sheathing had been removed a little while, however, the roof became literally a mushroom bed. Sporophores of the former fungus appeared over a period of several weeks, taking about four days for each to become mature. The time of fruiting was the last of June and the first part of July.

The sporophores found in this mill were for the most part quite definitely those of *Lentinus lepideus* in size, shape, and color. They were larger than the size given for *L. tigrinus* by most mycologists and the largest had a greater diameter than the measurements given by Harper (4, p. 371). The majority measured two or four inches, but a few were six or seven inches across. They were not at all umbilicate. Most of them were chalky white and quite smooth, but where there were scales they were of the "lepideus" type—spot-like and not hairy as are those of *L. tigrinus*. An annulus was present in some of the specimens. In parts of the hymenium of some of the sporophores there was a pseudo-veil of hyphae over the gills and the gills were laid flat and appressed one to the other. The hyphae of this veil bore chlamydospores like those already described (8, p. 29), and there was also an abundance of conidia, whether on this mycelium or belonging to a mold could not be determined. The size of the spores in these collections varied somewhat. Spores from some collections measured 7–10.5 x 3 μ, and spores from others were smaller than the measurements given for *L. lepideus*, being within the limits given

for *L. tigrinus* (5–8 x 2.5–4 μ). The writer has found that spores from fungi grown under mill conditions are occasionally smaller than the measurements usually given for a species. This has been found to be true several times with *Lenzites sepiaria* and also, although less often, with *L. trabea* and *Trametes serialis*.

A few mushroom sporophores found with those just mentioned were somewhat different. They were browned and blackened considerably, dried down to a brittle consistency, showing little scaling of the pileus, and instead of being umbilicate were decidedly umbonate. They were larger than the size attained by *Lentinus tigrinus* out of doors, being 5–10 cm. in diameter. They had a pseudo-veil of hyphae which completely covered the gills. The hyphae bore the same type of brown chlamydospores as mentioned above and described previously (*loc. cit.*). This type of sporophore would be more likely to be confused with the abnormal forms of *L. tigrinus*. This browned form is, however, only a stage in the disintegration of the mature sporophore of *L. lepideus*. In one mill, in an opening between planks two inches wide were found all stages of the latter fungus from the fresh white sporulating pilei through the browned, "veiled" type just described, to entirely blackened, shriveled remains rapidly falling to pieces.

Culturally the two fungi are quite distinct. Cultures of the two species have been obtained from the following sources: *L. lepideus* from Lewis, N. Y., and North Conway, N. H., collected by the writer, and from Syracuse, N. Y., collected by Dr. L. H. Pennington; sporophores from the mills mentioned above, collected by F. J. Hoxie and by the writer; *L. tigrinus* collected at Syracuse, N. Y., by Dr. L. H. Pennington; and a culture of *L. tigrinus* loaned by Dr. C. J. Humphrey. Cultures could not be obtained from the blackened, veiled sporophores which have just been mentioned.

There is a point of interest in connection with the culture of *Lentinus tigrinus* obtained from Dr. L. H. Pennington's collection. It was collected in September, 1915, and presumably kept at ordinary room conditions in his herbarium. The specimens were sent to the writer in 1920. In the fall of that year, just five years after collection, the spores germinated at high percentages and single spore cultures were readily obtained. Hence, these spores pro-

tected in the hymenium by the "veil" had remained viable for five years.

The cultures of *Lentinus lepideus* have already been described (*loc. cit.*). *L. tigrinus* shows distinguishable differences in growth on agar, beans, and wood. On agar it forms an abundant white felty growth which later becomes partly verona brown to warm sepia or natal brown, especially on the edges of the cultures, and exudes colorless to brown droplets. *L. tigrinus* has chlamydospores like those of *L. lepideus* (see Lyman, 6, p. 184, pl. 22, figs. 110–114). At 30° C., *L. tigrinus* covers a 100 cm. petri dish in 5 days, whereas *L. lepideus* grows only 15–17 mm. in that time at the same temperature. *L. tigrinus* also forms fruit bodies of the *Lentodium squamulosum* type (Lyman, 6, p. 184, and pl. 23) on both beans and agar (plate 17, fig. 5), while *L. lepideus* in four years of culture has never got beyond the "stump" formation on agar. It has fruited on wood, however. *L. tigrinus* often fruits on beans in 4 days from the time of inoculation. The strong aromatic odor characteristic of all the *L. lepideus* cultures used by the writer on agar or wood has not been noted in the cultures of *L. tigrinus*.

In wood cultures the differences between the two are more striking. *L. lepideus* forms a vigorous soft white cottony growth covering the culture blocks. On coniferous woods *L. tigrinus* grows very poorly and has done very little better on the basswood substrate provided. It does not form the uniform, delicate white weft characteristic of *L. lepideus*, but the slowly advancing growth soon becomes matted and tough and in color is white to the various shades of brown noted in the agar cultures. The growth is bordered by an irregular, crinkled, sulcate zone which is quite different from that seen in any other fungus by the writer.

To gain further evidence as to the identity of the Lentinus occurring in the mills, cultures from a mill collection and from a known specimen of *Lentinus tigrinus* were compared as to their respective abilities to attack the woods from hardwood and coniferous trees.

It was shown (Table II) that *L. tigrinus* is definitely a hardwood fungus. It did not attack any of the coniferous heartwoods,

although it decayed blue-stained western yellow pine sapwood a little. With the hardwoods, the decay induced by this species was much more pronounced, especially in Norway maple and redgum, although *L. lepideus* rotted white oak and basswood more than did *L. tigrinus*.

TABLE II

COMPARATIVE ABILITIES OF *Lentinus lepideus* AND *L. tigrinus* TO ATTACK THE WOODS OF CERTAIN CONIFEROUS AND HARDWOOD TREES, AS INDICATED BY PERCENTAGE LOSS OF OVEN DRY WEIGHT AFTER ONE YEAR OF INCUBATION AT ROOM TEMPERATURE

	Lentinus lepideus, per cent	*Lentinus tigrinus*, per cent
Cypress (*Taxodium distichum*)	34	3
Port Orford cedar (*Chamaecpyaris lawsoniana*)	12	2
Southern yellow pine (*Pinus palustris*)	24	0
Douglas fir (*Pseudotsuga taxifolia*)	20	0
Western yellow pine sapwood (*Pinus ponderosa*)	24	9
Sitka spruce (*Picea sitchensis*)	25	0
Eastern white pine (*Pinus strobus*)	25	0
White oak (*Quercus alba*)	24	1
Norway maple (*Acer pseudoplatanus*)	35	45
Redgum (*Liquidambar styraciflua*)	24	40
Basswood (*Tilia americana*)	15	10
Yellow poplar (*Liriodendron tulipifera*)	3	20

The apparent impossibility of *L. tigrinus* growing upon a roof made of coniferous timbers and all the evidence preceding leave little opportunity for calling any of the mill forms of Lentinus thus far collected anything but *L. lepideus*.

The taxonomy and morphology of the form of *Lentinus tigrinus* with the abnormal gills have been discussed by various writers, especially since Morgan (7) maintained that it was autonomous and named it *Lentodium squamulosum*. Lyman (6, p. 188) agreed with Morgan, for in his culture studies he produced the same type of fruit bodies from spore cultures. In reference to this latter work, Harper (4, p. 377) has suggested that the so-called "veil" of this form is a layer of parasitic hyphae, and that Lyman's cultures may have been contaminated by the conidia of the parasite. He remarks that to make the evidence complete, cultures should have been made from the normal form and from mixtures of both forms. The writer was unable to do this to complete the case, but

has one other point of evidence which corroborates Lyman's work. The cultures of *Lentinus tigrinus* used (*Lentodium squamulosum* form, it will be remembered) were obtained from single basidiospores, as mentioned above, and the results were similar to Lyman's—*i.e.*, the abnormal form of fruit body was obtained in every culture. It would be desirable to make the other cultures as Harper suggests, but the writer's single basidiospore cultures satisfy Harper's most serious criticism, because there can be no question of contamination in these cultures.

SUMMARY

Observations are recorded upon the occurrence of the following fungi in cotton mills: *Fuligo ovata* (Schaeff.) Macbr., *Stemonitis fusca* (Roth) Rost., *Reticularia lycoperdon* Bull., *Peniophora pubera* (Fr.) Burt, *P. gigantea* (Fr.) Mass, *Coniophora cerebella* Pers., and *Merulius lacrymans* (Wulf.) ex Fr.

Lenzites sepiaria Fr. and *L. trabea* Pers. ex Fr. are compared as to their importance in the decay of coniferous roof planks, time and manner of fruiting within mills, identification, cultural characters, etc.

Authentic cases of decay of weave shed roofs by *Trametes serialis* Fr. are reported. The danger is emphasized of imputing certain cases of decay to *Fomes officinalis* Vill. because of a similarity of characters shared by this species and abortive forms of *Trametes serialis*.

Brief observations are reported upon the occurrence and cultural characters of *Trametes carnea* Nees ex Cooke (called *Fomes roseus* Alb. and Sch. ex Cooke in a previous paper).

Evidence is adduced to show that the Lentinus found decaying weave shed roofs is *L. lepideus* Fr. and not *L. tigrinus* Fr. This evidence is derived from a comparative study of the sporophores, spores, wood and agar cultures of the two species, and durability tests upon woods of coniferous and hardwood trees. *L. tigrinus* was unable to decay any of the coniferous heartwoods tried.

Basidiospores of *Lentinus tigrinus* from beneath the veil of a specimen kept in a herbarium for five years germinated at high percentages. The writer's single basidiospore culture of this species adds another bit of evidence to the discussion of the questioned

autonomous nature of the *Lentodium squamulosum* form of *Lentinus tigrinus*.

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EXPLANATION OF PLATE 16

Fig. 1. Surface view of mature, resupinate, fruiting body of *Trametes serialis* collected from a spruce weave shed roof. Nat. size.

Figs. 2 and 3. Sectional view of mature fruiting bodies of *Trametes serialis* growing from cracks between spruce planks of weave shed roof. Nat. size.

Fig. 4. Mature sporulating sporophore of *Lentinus lepideus* from a spruce weave shed roof. Nat. size.

Fig. 5. Fruit bodies of *Lentinus tigrinus* (*Lentodium squamulosum* form) formed upon bean cultures in four days after inoculation. Nat. size.

GENERIC CONCEPTS IN THE PYTHIACEAE AND BLASTOCLADIACEAE

H. M. Fitzpatrick

I. Concerning Septocladia Coker & Grant

In a recent paper bearing the title "A New Genus of Water Mold Related to *Blastocladia*" the above genus is described as new by Coker & Grant.[1] The authors base the genus on a single species, *S. dichotoma* n. sp., which differs from the members of *Blastocladia* strikingly in that its thallus is normally and regularly septate. The species is compared with the four species of *Blastocladia* described by v. Minden in his treatment of the Blastocladiaceae in Kryptogamenflora der Mark Brandenburg,[2] and a detailed description and figures are given. Unfortunately, several papers of importance in this connection have been overlooked.

Butler [3] and Barrett,[4] working independently, published almost simultaneously descriptions of two species which are clearly congeneric with that described by Coker & Grant. Butler called attention to the septate character of the thallus and founded the genus *Allomyces* to include his species which he named *A. arbuscula* n. sp. Barrett, approaching the study of his species from the cytological point of view, studied material both *in toto* and in paraffin section, and was able to demonstrate that the septa are merely perforated pseudo septa comparable to those of the Leptomitaceae. He was content to widen the limits of the genus *Blastocladia* to include his species which he named *B. strangulata* n. sp. Four years later v. Minden [5] incorporated the species in the genus

[1] Jour. Elisha Mitchell Sci. Soc. **37**: 180–182. *pl. 32.* 1922.

[2] **5**: 601–606. 1912.

[3] On *Allomyces*, a New Aquatic Fungus. Ann. Bot. **25**: 1023. 1911.

[4] The Development of *Blastocladia strangulata* n. sp. Bot. Gaz. **54**: 353–371. *pl. 18–20.* 1912.

[5] Beiträge zur Biologie und Systematik einheimischer submerser Phycomyceten. *In* R. Falck, Mykologische Untersuchungen und Berichte 214. 1916.

Allomyces Butler as *A. strangulata* (Barrett) v. Minden. The genus including this species and that of Butler, and *Blastocladia* embracing the four species above mentioned, constitute the new order Blastocladineae in v. Minden's revised classification. The two genera are very closely related.

A critical examination of the description and figures published by Coker & Grant reveals no evident point of difference between their species and that of Barrett, and the writer considers them to be the same. The material in both cases was collected in the eastern United States.

II. RHEOSPORANGIUM APHANIDERMATUM Edson

Several years ago Edson [6] cited *Aphanomyces levis* DeBary as the cause of a new seedling disease of sugar beets. Later he [7] discovered that his fungus was in fact not that species, and, failing to find in the Saprolegniales a genus which would include it, he [8] founded for its reception the new genus *Rheosporangium*. As a basis for his taxonomic study he used the classification of v. Minden [9] in which the Pythiaceae are excluded from the Saprolegniales. Edson's description of *Rheosporangium* and the drawings illustrating it recalled at once to the writer's mind the genus *Nematosporangium* Schroet.[10] of the Pythiaceae. This genus is equivalent to the subgenus *Aphragmium* of *Pythium* as treated by Butler,[11] and includes those species in which the sporangium is filamentous in character. The members of the group are for the most part parasitic in algae. Butler describes *P. gracile* Schenk. as occurring in green algae and also as causing a serious disease of ginger (*Zingiber officinale*) in India. The fungus on ginger has been segregated under the new specific name, *P. Butleri*, by Subra-

[6] Damping-off and Root-rot Parasites of Sugar Beets. Phytopathology 3: 76. 1913.

[7] Seedling Diseases of Sugar Beets and their Relation to Root-rot and crown-rot. Jour. Agr. Res. 4: 165. 1915.

[8] *Rheosporangium aphanidermatus*, a New Genus and Species of Fungus Parasitic on Sugar Beets and Radishes. Jour. Agr. Res. 4: 291. 1915.

[9] Saprolegniineae. Kryptogamenflora der Mark Brandenburg 5: 504. 1912.

[10] Engler & Prantl. Die Natürlichen Pflanzenfamilien 1[1]: 104. 1893.

[11] An Account of the Genus *Pythium* and Some Chytridiaceae. Mem. Dep. Agr. India Bot. ser. 1: 61. 1907.

maniam,[12] who states that it also attacks tobacco and papaya. Finally, Carpenter [13] has found the same organism in Hawaii causing the Lahaina disease of sugar cane. Carpenter has compared his fungus with that of Subramaniam and with *Rheosporangium aphanidermatum* Edson and finds them all to be one species. He applies the name *Pythium Butleri* Subramaniam. As the specific name of Edson antedates that of Subramaniam the binomial **Pythium aphanidermatum** (Edson) comb. nov. is to be preferred. If the genus *Nematosporangium* is recognized, which seems to the writer desirable, then the species should bear the name **Nematosporangium aphanidermatum** (Edson) comb. nov.

In *Nematosporangium* the swarmspores are freed from a thin-walled vesicle or bladder which forms at the mouth of the sporangium. Edson designates this vesicle as the sporangium, and introduces the new term "presporangium" to apply to the sporangium proper. This terminology has little to recommend it, and if used in the closely related group, *Phytophthora,* would lead to confusion, since there, in a single species, the sporangium may free its swarmspores with or without the formation of a vesicle. The older term "prosporangium" used by other authors in similar situations should be preferred to "presporangium" in any case.

III. THE PYTHIUM-PHYTOPHTHORA PROBLEM

A critical reading of the papers which have appeared in recent years dealing with the various species of *Pythium* and *Phytophthora* must have raised in the minds of many students the question of the identity of these genera. The effort will here be made to review the salient features of the situation, and to present the evidence indicating that the two genera should be united.

Pringsheim in founding the genus *Pythium* placed it in the Saprolegniaceae. DeBary recognized its affinities with his own genus *Phytophthora,* and classed both with the Peronosporaceae. The majority of the students of the Phycomycetes, including

[12] A Pythium Disease of Ginger, Tobacco, and Papaya. Mem. Dep. Agr. India **10**: 181–194. 1919.

[13] Morphological Studies of the Pythium-like Fungi Associated with Root-rot in Hawaii. Bull. Exp. Sta. Hawaiian Sugar Planters' Assoc. Bot. ser. **3**: 62. 1921.

Fischer, Butler, and v. Minden, have agreed with DeBary, while a few have returned to the older point of view of Pringsheim. Schroeter [14] has elevated the subgenus *Nematosporangium* of *Pythium* to generic rank, and makes this genus and *Pythium* the basis of a separate family of the Saprolegniales, the Pythiaceae, coördinate with the Saprolegniaceae and Leptomitaceae. He includes *Phytophthora* in the Peronosporaceae, calling attention to the fact that it differs from the other genera of the family in developing its sporangia successively rather than simultaneously. He fails to give an adequate separation of the Pythiaceae and Peronosporaceae. Fischer [15] treats *Pythium* and *Phytophthora* as closely related genera of the Peronosporaceae, and points out that they differ from the higher genera of the family not only in the successive development of their sporangia, but also in lacking a well-defined conidiophore. His basis for the separation of *Pythium* and *Phytophthora* is in the light of our present knowledge insufficient. In general it can be said that these genera differ far more strikingly from the other genera of the Peronosporaceae than they do from each other.

We are indebted chiefly to Butler [16] for our knowledge of the genus *Pythium*. His monographic account of the genus is, in fact, the only general paper of importance in this field. His statements with reference to the basis for the separation of *Pythium* and *Phytophthora* may be said to be, therefore, the most authoritative which we have. He admits that the genera are very closely related, but says:

"The genus *Pythium* is separated from all the rest (of the Peronosporaceae) by liberating its zoöspores in an imperfectly differentiated state into a bladder at the mouth of the sporange, in which differentiation is completed. There are other minor differences, such as aërial habitat and parasitism of the Peronosporaceae, the formation of haustoria correlative with the latter, etc. None of these differences are absolute."

In other parts of the same paper he emphasizes the point that the delimitation of the zoöspores begins in the sporangium and is

[14] Engler & Prantl. Die Natürlichen Pflanzenfamilien 1^1: 104. 1893.
[15] Rabenhorst. Kryptogamenflora von Deutschland etc. 4: 391. 1892.
[16] Mem. Dep. Agr. India Bot. ser. 1: 1–158. *pl. 1–10.* 1907.

completed in the thin-walled vesicle at its mouth. For example, in describing the discharge of the sporangium as observed in *Pythium rostratum* he writes:

"The flow resembled that of porridge forced through a hole, but with one difference. The granule directly opposite the opening was not always the first to escape. It was sometimes shoved aside by one to the right or left. From this I have been led to suppose that even at this stage the spore-origins are definitely formed and that, though fused into a mass in which individual spores can not be made out, yet each nucleus has obtained a hold on a certain mass of cytoplasm which passes out with that nucleus. Hence in passing out, when the nucleus engages in the tube it draws its cytoplasm with it, whether this be directly in the center or to one side of the opening."

At another place he says: "In the vesicle the *final fashioning* of the zoöspores occurs."

The formation of a thin-walled vesicle at the mouth of the sporangium is not restricted to *Pythium*. A similar structure has been described in *Polyphagus, Myzocytium, Lagenidium, Rhipidium*, and other genera of the lower Phycomycetes, while Dastur [17] and Rosenbaum [18] state that it is sometimes formed in at least a part of the species of *Phytophthora*. It has been seen in *Phytophthora cactorum, P. arecae*, and *P. parasitica* by Rosenbaum and in *P. parasitica* by Dastur. The former writer says: "Perhaps its evanescent nature explains why it had not been previously observed in some or in all the forms." As is well known, the more usual type of swarmspore discharge in *Phytophthora* is that in which the spores escape directly from the mouth of the sporangium without the formation of the bladder.

Butler in the paper referred to above describes somewhat imperfectly under the name *Pythium palmivorum* a species which in its various characters may be said to be strikingly similar to *Phytophthora*. In a later contribution [19] he discusses this species at con-

[17] On *Phytophthora parasitica* nov. spec., a New Disease of the Castor Oil Plant. Mem. Dep. Agr. India Bot. ser. **5**: 177–231. 1913.

[18] Studies of the Genus *Phytophthora*. Jour. Agr. Res. **8**: 252. 1917.

[19] The Bud-rot of Palms in India. Mem. Dep. Agr. India Bot. ser. 3: 221–280. *pl. 1–5*. 1910.

siderable length, and in the description of sporangial germination says:

"Four types of germination occur, which, though distinct enough in appearance, are all modifications of the one process. The most characteristic, though by no means the most common, is that which is practically universal in the genus *Pythium* and which is *the only absolute mark of distinction* of this genus from *Phytophthora*. In this case the apex of the papilla swells up into a thin gelatinous vesicle into which the protoplasm of the sporangium passes in a uniform granular mass. Within the vesicle it segments to form a number of zoöspores, which develop cilia and move ever more vigorously in the confined space, until the vesicle wall ruptures and the spores swim off in all directions. In some cultures prolonged search was necessary to find instances of this type of germination; in others it was quite common. On the whole it is less frequent in the cooler months of the year than that next to be described.

"This is simply an incomplete form of the last, in which the vesicle is either not formed at all, the apex of the papilla dissolving, or if formed, ruptures almost immediately. Segmentation into zoöspores occurs within the sporangium, and is complete or nearly complete before the papilla opens. As soon as an opening forms, the protoplasm streams out and breaks up at once into free swimming zoöspores. Owing to the pressure of the mass within the sporangium it is not possible to distinguish the individual zoöspores before escape, but it is evident that they must be fully formed before the rupture of the papilla, since they separate at once after escape, and also because as soon as pressure is reduced by the extrusion of part of the sporangial protoplasm, the remainder may segment while still inside and emerge as fully formed mature zoöspores. This is the type of zoöspore formation habitually met in *Phytophthora,* and in several cases the palm parasite would have been taken for a *Phytophthora* had not prolonged search revealed an occasional instance of the first type of discharge. Intermediate types between the two are sometimes found. Thus in one case about three quarters of the protoplasm emerged in a mass surrounded by a vesicle, which then dissolved, and the

mass at once broke up into individual zoöspores, as did the remaining one quarter still within the sporangium at the moment of rupture of the vesicle. Sometimes the vesicle is formed in the ordinary way, but the zoöspores are almost mature when they leave the sporangium and the vesicle early dissolves to liberate them."

The third type of germination described is that in which zoöspores failing to escape from the sporangium round off and germinate *in situ*. The fourth is that in which the unopened sporangium germinates by one to several germ tubes.

The species seems to be an obligate parasite. Its mycelium is intercellular and bears haustoria. Definite conidiophores do not occur, the sporangia being borne on the ordinary hyphae.

In a recent paper Sharples and Lambourne [20] state that "Butler has reconsidered this fungus as *Phytophthora palmivora.*" They make no further comment on the change, and he apparently has not published under the new name.

Though the transfer of the species to *Phytophthora* removes from *Pythium* the only species of the genus in which the zoöspores have been described as escaping directly from the sporangium, it places in *Phytophthora* a species in which zoöspore formation may take place in the manner described as typical of *Pythium*. The species furnishes, in other words, a form intermediate in its characters between the two recognized generic concepts, and leaves us without even a single "absolute mark of distinction" between them.

The attempt to determine the exact points in sporangial discharge at which zoöspore formation begins and ends, for use as a basis for segregation of the species of this general group into the two genera, *Pythium* and *Phytophthora,* seems at best an unsatisfactory procedure. Unless a more tangible taxonomic character can be found to serve for this separation it would be less confusing to merge the two genera into one. In fact, in the light of our present knowledge there seems to be no other course to pursue. In this connection it should be mentioned that Lafferty & Pethybridge [21] in a recent paper show that there is no longer a basis for

[20] Observations in Malaya on Bud-rot of Coconuts. Ann. Bot. **36**: 55–70. 1922.

[21] Sci. Proc. Roy. Dublin Soc. **17**: 29–43. *pl. 1–2.* 1922.

the recognition of the genus *Nozemia,* several species having been found to possess both amphigynous and paragynous antheridia. In merging the genera *Pythium* and *Phytophthora,* the name *Pythium* would of necessity be retained for the group, since it is the older.[22]

The writer suggests that the family Pythiaceae, consisting of the forms now included in *Pythium* and *Phytophthora,* and their nearest relatives, *Pythiogeton* and *Pythiacystis,*[23] be incorporated in the Peronosporales as a family distinct from the Peronosporaceae. These forms differ from the Peronosporaceae (*Plasmopara, Sclerospora, Peronospora,* etc.) in their successive development of sporangia, the absence of well-defined conidiophores, their saprophytic tendencies, less typically deciduous sporangia, etc.

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[22] It is not the writer's intention that this discussion be regarded as constituting the actual merging of the two genera.

[23] *Pythiacystis* should apparently be merged with *Phytophthora.* See Phytopathology **7**: 150. 1917 and **10**: 397. 1920.

PHOMA: A SAMPLE OF MYCOLOGICAL NOMENCLATURE AND CLASSIFICATION[1]

C. L. Shear

When asked by our non-botanical friends why we use jaw-breaking Latin names for plants instead of the common ones with which they are familiar and which seem to them much simpler and more appropriate, we are wont to explain in a very learned and impressive manner that the common names are local and lack precision, the same vernacular name being applied to different plants in different places, and that they would not be understood by foreigners or botanists in other localities. Latin, however, is the universal language of systematic biology, understood and used by botanists of all nations, and when a Latin binomial name is written every botanist in the world knows exactly what plant is referred to; but if you should refer to the plant by its common English name, you might not be understood by all English-speaking people, and probably not at all by foreigners. The natural inference of the innocent bystander might be that the name we use is the only Latin name applied to the particular plant, and that this name is not applied to any other plant. Most systematic botanists at least know, and all others should know, that the above statement regarding Latin names is not in accordance with the facts, as most plants have several or many Latin binomial names, and at present there is no uniform usage throughout the botanical world either in the use or application of either generic or specific names. The condition in nomenclature and taxonomy is bad enough as it obtains among flowering plants which are conspicuous objects, long known and studied. When, however, one makes more than the most superficial study of the condition existing among the fungi, he finds that, in general, chaos rather than order and system prevails in the application and limitation of generic and specific

[1] Read before the Mycological Section of the Botanical Society of America at the Boston Meeting, Dec. 28, 1922.

names. Among the higher and more conspicuous fungi this condition is naturally less striking than among the smaller organisms, which require careful microscopic study to determine their distinctive morphological characters and relationships.

As an example of the present rather general condition, let us trace briefly the nomenclatorial history of *Phoma*, a name so common as to be familiar to the beginner in mycology. Examining the 22 volumes of Saccardo's Sylloge fungorum, which only brings us down to 1913, we find *1722* so-called species of *Phoma* given. A considerable genus! An " omnium-gatherum " would be a much more appropriate designation than " genus " for this heterogeneous mass of material.

The genus *Phoma* was first described by Fries (**1819**) as follows: " PHOMA. Differt thecarum indole & perithecii defectu a Sphaeria. Typus: *Sph. pustula* P." Being translated, I take this to mean that the genus *Phoma* differs from *Sphaeria* in the nature of the asci and in lacking perithecia, and that the type is *Sphaeria pustula* Pers. It would seem evident to any mycologist at present that this description alone was scarcely sufficient for the satisfactory identification of a fungus-genus. The same remark would apply, however, to some of the generic descriptions published at present. Before judging our distinguished predecessor too harshly we should consider the condition of mycology at that time and the prevailing lack of knowledge of the morphology of the smaller fungi, especially the pyrenomycetes, which then included not only the ascogenous forms with true perithecia, but also practically all the imperfect, pycnial forms which were largely referred to the old genus *Sphaeria*.

In order to understand the situation, we must remember that a totally different concept of the origin and development of the organic world obtained a century or two ago from that which is in vogue among biologists today. Species at that time were believed to have been created directly by omnipotent edict and fashioned by the Creator according to particular ideals or models and were constant in character. You may recall that one of the explanations of the occurrence of fossil animals and plants given by some churchmen and philosophers was that they were the discarded

models from the Creator's work shop. Botanists and zoölogists were also influenced by these beliefs and this probably was Fries's idea in specifying the type, as he (**1835**) said later, in speaking of a natural system, that it is really supernatural and that each division of such a system is the expression of an idea in a living form.[2] Since he distinctly specifies that *Sphaeria pustula* Pers. is the type of the genus, it would seem rather natural that this plant, which had been fairly well described by Persoon and was correctly identified and distributed later by Fries, should have been taken as the basis for the interpretation and application of his generic name. Fries himself apparently did attempt to refer to the genus only such species as his very limited knowledge of their microscopical characters led him to believe were congeneric with his type.

In 1823 Fries again in his Systema mycologicum treated *Phoma*, modifying and enlarging the description somewhat and stating that neither perithecia nor asci were present, but including his original type, *P. pustula*, and also *Sphaeria saligna* Ehrh., both of which, notwithstanding his description, have good perithecia and asci. He also included several other species of pycnial forms. During the interval between 1819 and 1823 he had apparently retrogressed in his knowledge of the true character of the plant which he originally called *Phoma*.

In 1825, in Systema orbis vegetabilis, he again discussed the genus, attributing to it essentially the same characters as before and placing it in his order Cytosporei, which he describes as having "asci wanting or disappearing; or rather sporidia, sacks or cells, which may be depauperate asci, that is, thecae of authors." Fries, as well as most other mycologists of that period, did not have a clear idea of true asci. Besides the true ascus the term was frequently applied to a multiseptate spore or to a spore containing vacuoles or oil globules. In 1828, in Elenchus fungorum, Fries added another species, *P. hederae* Desm., to the genus. Subsequent authors such as Wallroth (**1833**), Berkeley (**1836**), Corda (**1842**), and Rabenhorst (**1844**) simply repeat in substance Fries's

[2] This is a free translation of a quotation from Fries, l.c. given in Sachs' History of Botany, Eng. Trans., p. 111, 1906. I have been unable to find the latter half of Sachs' quotation in the book cited, but as no page is given it may have been overlooked.

description and refer to the genus, the species he originally used, *P. pustula* and *P. saligna.* Léveillé (**1845**) referred to the genus a species which was probably what is now called *Sphaeropsis.*

In 1849 Fries, in Summa vegetabilium Scandinaviae, published his last account of the genus *Phoma* and says in italics at the end of the diagnosis, "*typically ascigerous,*" and includes four species, his original monotype, *P. pustula,* also *P. saligna, P. populi,* and *P. hederae.* The last, however, a nonascogenous form, he says he does not consider a good *Phoma.* It is clear from this that in the interval between 1825 and 1849 he had discovered that his original type as well as *P. saligna,* which he had already referred to the genus, contained good asci. Therefore, he corrected his previous descriptions and emphasized this character.

Up to 1849 comparatively few species had been referred to the genus by Fries or other authors and these were in part true pyrenomycetes with good perithecia and asci. There would seem to have been no justification, therefore, for applying the name to pycnial forms only. The same year, however, Desmazières, who was describing numerous "new species" of fungi, decided that the *Phoma* of Fries needed emending. Possibly he had not seen Fries's latest statement regarding it. He published a new description of the genus in which he states that it should be characterized as having membranaceous or corneous perithecia without asci, that is, true pycnia, according to present terminology, but with filiform basidia bearing terminal, minute, hyaline sporidia with two sporules. These were in reality only vesicles or oil globules. He further remarks that the form of the sporidia and the presence of two globose sporules is important and discusses the supposed nature of these so-called sporules, which he says some authors have interpreted as merely shadows. He also adds that Montagne is correct in considering these fruiting bodies as false perithecia.

It will be observed that the characters which Desmazières ascribed to *Phoma* are very different from those which had previously been attributed to it by Fries and other mycologists. He says that mycologists should not be the slaves of ancient ideas, and that he desires, without disturbing the "natural relations" of the genus, to avoid the difficulties arising from the application of too

restricted characters, which continually shackle mycologists. He then proceeds to describe and refer to his "emended" genus 10 species, all of which are pycnial forms, only two of which had been previously described, and none of which had ever before been referred to the genus *Phoma*. It certainly requires a great stretch of the imagination to see any relation between Fries's genus *Phoma* and that of Desmazières. In reality Desmazières simply applied the name *Phoma* to an entirely different group of fungi from that for which it was intended by Fries, and it is therefore no more or less than a homonym. If Desmazières could behold the result of his efforts to prevent the "shackling" of mycologists in the use and application of *Phoma*, it might perhaps exceed his fondest expectations.

Referring to Saccardo's compilation of the so-called species of *Phoma*, we find, as already stated, over 1,700, and they are still being multiplied rapidly. To refer a fungus to *Phoma* at present is little more than a confession of ignorance of the organism in hand or its relationship. It is about as scientific and satisfactory a method of classifying fungi as dumping miscellaneous letters into a waste-basket would be of filing correspondence.

Following Desmazières's example subsequent mycologists continued to refer the great bulk of pycnial, and in some cases non-pycnial, forms having hyaline, nonseptate spores to this so-called genus. This proceeded until 1882, when Saccardo (**1882**) tried his hand at further "emendation" of the genus and described it as follows: Perithecia smooth, without a beak, subcutaneous not maculicolous [this is supposed to separate it from *Phyllosticta*], spores without appendages. This, however, did not improve matters much so far as restricting its application was concerned.

The great number of so-called species of *Phoma* and the great diversity of their morphological characters and relationship finally so forcibly impressed some of the mycologists, who had made a little closer study of the microscopic characters of some of the plants, that they began to lop off from the great heterogeneous mass groups of species here and there, which were clearly distinguished by some more or less conspicuous character. Thus were segregated *Macrophoma, Dendrophoma, Rhyncophoma,* and many

other genera. No one, however, attempted to attack the problem in a systematic or scientific manner and the final result of this method, or lack of method rather, if pursued to its logical conclusion, will be that finally the name *Phoma* will be left stranded with a lot of odds and ends of species listed in an appendix as "imperfecte cognitae," as is already the case with the old generic name *Sphaeria*. This sad fate, however, may perhaps be averted if mycologists can be led to apply some rational method to the treatment of nomenclature and taxonomy.

The idea of anchoring generic and specific names by attaching them permanently to a particular species or individual to which they were first applied—that is, a nomenclatorial type—is gradually becoming recognized as a practical and consistent method of avoiding some of the serious difficulties into which past practices, such as we have just described, have led us. The earlier mycologists were so busy naming new species and genera that they did not usually take time to determine their characters in detail or with the accuracy which might have been attained with the imperfect microscopes available, and even today descriptions are so far from perfect that they can not safely be relied upon as the primary basis for fixing or applying names.

It is most remarkable how prone we still are to confuse ideas or concepts with things. It seems necessary to get more firmly established in our minds the fact that genera and species of living organisms consist of material entities and not metaphysical concepts, and that they are made up of individuals and groups of individuals, and also that our nomenclature and taxonomy must be based on these material things and not on incomplete or inaccurate descriptions of them. No description, however detailed, can completely depict a species or genus. The only way we can get any adequate idea of either is by thorough study and comparison of actual specimens or individuals (the more of them the better) of the organism described.

In this connection it is very important to make clear what is evidently not so in the minds of some, and that is the difference between so-called biological and nomenclatorial types. The biological type in its present conception seems to be a sort of emended

or modernized application of the old idea, which we have mentioned regarding the supposed models followed in creation. The biological type of a genus would be the particular species of a genus, which embodies in itself all of the essential and fundamental characters of the genus—that is, an ideal species of which all other members of the group are clearly modified forms—whereas the nomenclatorial type is simply the species to which the original author first applied the name (or one of the species, where several were used) and which serves to fix the generic name in its particular application and usage. Consequently the nomenclatorial type of a genus may not be identical with its biological type (supposing that such a thing exists), but may happen to be a species which is more or less atypical, but still can be recognized as belonging to a distinct group of species to which the generic name is applied. The definite limitations of a genus can not and should not be fixed, as they must change more or less with advancing knowledge and with the various interpretations of monographers.

The idea of applying the method of generic and specific types, as a means of securing greater stability and uniformity in the application of names, has been gradually receiving more and more attention from systematic botanists, and when its advantages are thoroughly understood will probably be adopted, as it has already been by systematic zoölogists.

It has already appealed to a few mycologists so strongly that they have attempted to put it in practice according to their own individual ideas of its application. As there is obviously more than one possibility in the selection of a type in all except monotypic genera, it is very important that there should be a general agreement among mycologists as to the exact method to be pursued in determining the type in such cases, otherwise various and quite different results may be obtained by different workers and thus bring discredit to the method and fail to accomplish its purpose. This is aptly illustrated by the work of the late excellent mycologist, von Höhnel, in connection with this particular genus, *Phoma*.

Von Höhnel (**1918**) in discussing this genus begins by stating correctly that Fries originally established it in 1819 (a fact, by the

way, not usually stated by recent mycologists, who are too frequently satisfied by referring to any place where the author used the name or his most readily available or best known work). He also correctly states that Fries specified the type as *Sphaeria pustula* Pers. = *Hypospila pustula* of recent authors. He says the standard of judging the genus, however, should be Fries's account in his Systema in 1823, where *Phoma saligna* (Ehrh.) = *Linospora saligna* of recent authors happens to be mentioned first in the list of species, though *P. pustula* is also included. This would result in the application of the name *Phoma* to a different genus of pyrenomycetes from that to which it would be applied if Fries's original monotype were taken—*i.e.*, the present *Hypospila pustula*.

Von Höhnel does not so state, but the natural inference is that he took the type from Fries's Systema (**1823**), because this was one of the various dates selected at Brussels as the starting point for the nomenclature of certain groups of fungi. Even accepting this date, there seems to be no good reason why he should not have taken Fries's original type. Be this as it may, whichever species of Fries is taken as the type, there seems to be no way in which Fries's name, *Phoma,* can be properly applied to any of the species referred to it today.

The nomenclatorial type of the genus *Phoma* of Fries should undoubtedly be *Sphaeria pustula* Pers., which he distinctly specified as its type when he first established the genus. The type of *Phoma* of Desmazières is an entirely different thing and the name as used by him is a homonym and untenable on account of its earlier use by Fries.

It may seem to some that we are unduly disturbed over this question of nomenclature, and that its importance in mycology is much overestimated. I admit that life histories, physiology, comparative morphology, cytology, and various other phases of the subject are more interesting and of greater scientific importance. It can not be denied, however, that whatever branch of mycology one pursues, he is obliged to use names for the organisms he deals with, and, unless these names are applied with accuracy and uniformity by the different workers, great confusion and misunderstanding results and the progress of science is impeded.

We have now reached the stage in the development of systematic mycology where it is going to be necessary to revise greatly and rearrange the genera and species of fungi on the basis of a greater knowledge of their life histories, comparative morphology, and development. Whatever permanent success is attained must to a considerable extent depend upon the adoption of a satisfactory and generally approved and adopted method of fixing the application of the great mass of generic and specific names on a type basis.

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THE GENUS CHRYSOMYXA

JAMES R. WEIR

(WITH PLATE 17)

The genus *Chrysomyxa* was established by Unger in 1840 on *C. abietis* (Wallr.) Unger, an autoecious leptoform on *Picea* having only telia in its life cycle (*Leptochrysomyxa* of Winter). In this sense Arthur (1) restricted the genus and established *Melampsoropsis* (Schroet.) to include those species having all spore forms. Although the genus is usually interpreted as including both short and long cycle forms, it is here used in its restricted sense. It is interesting to note that the species having all spore forms have their pycnia and aecia also as far as known on *Picea*.

CHRYSOMYXA Unger

Original description of the genus:

Stroma mucose-granulosum inferius in floccos simplices vel ramosos, superius in utriculos asporos secedens parenchymate plantarum vegeto innatum.

The genus may be characterized as follows:

Telia single, rarely united, arranged in short or elongated sori in one or more rows, protruding in definite cylindric or tongue-shaped, lemon-yellow to orange-red waxy masses, pulvinate; teliospores produced in simple or branched columns of from 3–8 spores more or less united laterally, soon separating, oblong to cubic with smooth hyaline membrane, germinating as soon as mature with a typical promycelium. Basidiospores round to ovoid.

CHRYSOMYXA ABIETIS (Wallr.) Unger, Beitr. Vergl. Path. 24. 1840

Blennoria abietis Wallr. Allgem. Forst. u. Jagdzeitg. 65. 1834.
Caeoma piceum Hartig in Sched.
Uredo epidermoidalis Hartig, Verhandl. Harz. Forstv. 61. 1864.
Sphaeria navicularis Wallr. Tharandter Jahrbuch. 111. 1853.

Unger's original description is as follows:

Maculis elongatis, uni- v. biserialibus, flavo-rubicundis, dein epidermide rupta cinctis. In foliis *Pini abietis* L.

Redescription:

Telia foliicolous usually appearing on conspicuous yellow spots, or without change of color in the leaf, waxy, linear-oblong, single or united, 0.5–12 mm. long, 0.3–0.5 mm. broad, 0.5 mm. high, orange-yellow to reddish-brown, ruptured epidermis not conspicuous; teliospores catenulate in columns 50–100 μ long, cylindric-elongate, slightly enlarged above, orange-yellow 20.2–30 x 10–16 μ; wall colorless, 1 μ thick, smooth.

On Pinaceae.

Picea excelsa Link on imported nursery stock from Denmark, at Louisville, Kentucky, May, 1907, Weir. Hartz Mts., Saxony, and Hohenschwangau, Bavaria, 1909, Weir. Other collections in the writer's herbarium are from Austria, Switzerland, France, and Russia.

Farlow (*2*) refers a collection on *Abies canadensis* made in June, 1883, in Essex County, Massachusetts, to *C. abietis*, but with reservations owing to the immaturity of the material.

Chrysomyxa weirii Jackson, Phytopathology **7**: 353. 1917.

Original description:

O. Pycnia unknown, probably not formed.

III. Telia foliicolous on yellowish spots, prominent, waxy in consistency, elongate-elliptic, 0.5–1.5 mm. long, occasionally confluent, dull-orange to orange-brown, ruptured epidermis conspicuous; teliospores catenulate soon separating, oblong or fusiform, 5–7 x 16–28 μ, truncate or attenuate at either end, abutted or overlapping, sometimes only slightly so at one side; wall colorless, thin, 1 μ or less, smooth.

On Pinaceae.

Picea engelmanni Parry. Gold River, British Columbia, June 10, 1911, E. W. D. Holway; Priest River, Idaho, May, 1915, J. R. Weir, *68;* Whitman National Forest, Oregon, July 17, 1913, J. R. Weir, *271,* type.

The species has been collected abundantly at a few stations by the writer in Washington, Idaho, and Montana. It is chiefly distinguished from *C. abietis* by its larger and more conspicuous telial

column with less tendency to branch, less elongated sori, and by its narrower and smaller spores.

Since 1914 this interesting short cycle rust on *Picea* has been collected annually by the writer. In July and August, 1917, it was collected in abundance at Evaro, Montana, and near Victor, Montana, where a study was made on its life history. The rust occurs from practically sea level to the alpine zone, but is more abundant in the mountains of Idaho and Montana. Trees of all age classes are attacked, but it is usually most common on young trees whose crowns are overtopped. The rust is chiefly confined to the lower branches of mature trees. This is in common with most foliicolous forest-tree rusts. The factors for germination and infection are apparently less favorable the higher the crown. On isolated and individual trees ranging in age from 5–10 years the rust is often so prevalent as to kill all the needles on the young shoots, sometimes causing complete defoliation the following spring. The shoots thus defoliated rarely die, but produce a new crop of needles the following year. Infection occurs in early spring. The overwintered teliospores were found germinating on the still attached needles in April and May. The sporidia are carried by the wind to the tender needles of the new shoots, where they germinate and very rapidly cause infection. By the middle of May the infected needles become apparent by their yellowish banded appearance. The color is due to numerous particles of a yellow deposit in the mycelium which may be extracted in water to form a beautiful amber-colored liquid. The seat of infection may be on any part of the needle. The yellowish infected areas alternating with the deep-green of the uninfected parts gives the needles a very conspicuous appearance. The telial pustules, ranging in number from 1 to 5, are usually produced at the angles of the needles. By the last of June or July development is well advanced, but not complete. The infected needles remain on the tree and in the spring the telial stroma completes its development, ruptures the epidermis longitudinally, and appears as a waxy yellowish-orange column flattened laterally. The teliospores now germinate *in situ* and produce a 4-celled promycelium with sterigmata from which a single sporidium is produced. The new

needles of the season are infected and the cycle is repeated. After sporulation the telial pustules dry up and the needles fall from the tree.

Infections do not occur uniformly throughout a stand of spruce. Individuals here and there are infected year after year, while their nearest neighbors remain free from rust. Hartig (3) notes a similar condition in the case of *C. abietis* and attributes it to the backward growth of certain individuals at the time the sporidia are mature. There is no doubt, however, but that the rust occasionally adapts itself to a particular individual. Until 1918, when the tree was destroyed by fire, a young spruce about 15 years old, near the writer's field camp in the Priest River Valley, was regularly infected every year since its discovery in 1914. The rust was not present on any other tree in the neighborhood. The sporadic appearance of the rust on isolated trees makes it of little or no consequence as a disease to be combated.

The nature of the telia of this rust was demonstrated by the following experiment.

On June 12, 1917, the writer, assisted by E. E. Hubert, made hanging drop cultures in distilled water with fresh teliospores taken from newly ruptured pustules on *Picea engelmanni*. Within three days the teliospores had germinated, produced 4-celled promycelia, and developed sporidia. These sporidia were fairly large, globoid, with cell contents of an orange-yellow color. The teliospores were found to consist of a series of cells produced in succession toward the apex, usually of a characteristic, oblong, parallelogram or fusiform shape, and were arranged catenulate within the sorus. Using the germinating telia from the cultures, 2 inoculations under control were made on June 15, 1917, upon young needles of 2 seedlings of *Picea engelmanni* in the greenhouse. On July 30, 1917, yellow banded areas appeared upon a few of the needles of the inoculated plants. By the last of September of the same year these infections developed sufficiently to distinguish the telial layer. Pycnia were not developed. This experiment demonstrates clearly the autoecious nature of this rust.

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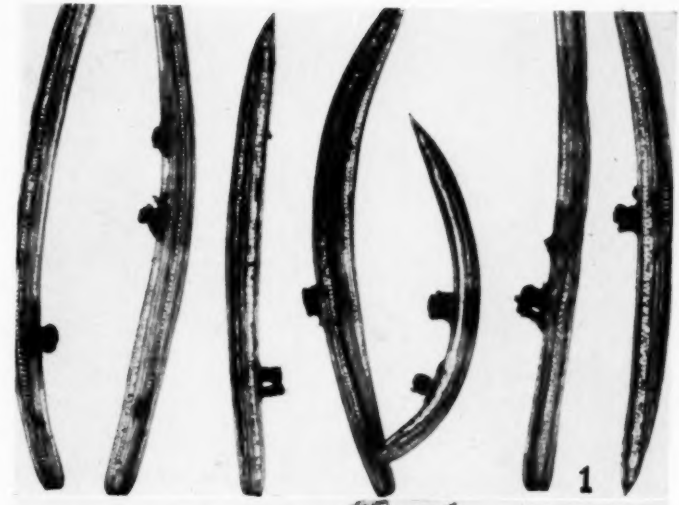

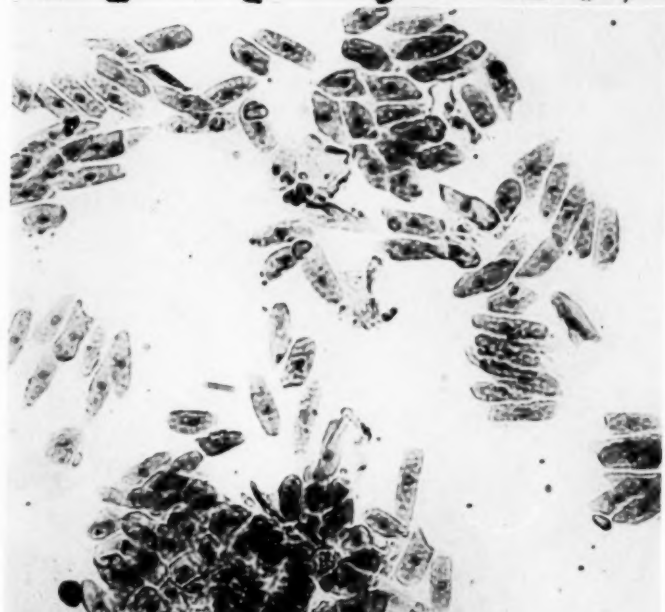

CHRYSOMYXA WEIRII JACKSON

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EXPLANATION OF PLATE 17

Material prepared by the writer and photographed with the assistance of A. S. Rhoads.

Fig. 1. Telia of *C. weirii* on leaves of *Picea engelmanni*.

Fig. 2. Teliospores of *C. weirii*. × 532.

NOTES AND BRIEF ARTICLES

(Unsigned notes are by the editor)

Mr. G. R. Bisby, Professor of Plant Pathology at Manitoba Agricultural College, has returned to Winnipeg after a year spent at the Imperial Bureau of Mycology, Kew, England, where he was associated with Dr. E. J. Butler.

Interesting fungi cultivated by ants are illustrated and described in a popular way by Prof. W. M. Wheeler in one of his series of articles on "Social Life Among the Insects," published in *The Scientific Monthly* for December, 1922.

Dr. Murrill was awarded a gold medal by the Holland Society of New York at its annual meeting at the Hotel Astor on March 6 in recognition of his distinguished service in the science of Mycology. After the presentation, he gave an illustrated address on "Fungi and Their Relation to Forestry in America."

Trachysphaeria fructigena is described by Tabor and Bunting in the January number of the *Annals of Botany* as a new genus and species of the Peronosporineae, responsible for a disease of cocoa and coffee fruits in the Gold Coast Colony. Full descriptions, notes, and illustrations are given of the various stages of this interesting new fungus.

An extensive, splendidly illustrated paper on "The Laccarias and Clitocybes of North Carolina," by Coker and Beardslee, appeared in the *Journal of the Elisha Mitchell Scientific Society* for September, 1922. With this excellent paper before him, the student of the Carolina fungi need have little difficulty in recognizing at least the principal members of this large and difficult group. Four species are treated by the authors under *Laccaria* and twenty under *Clitocybe*.

Dr. G. R. Lyman, plant pathologist of the U. S. Department of Agriculture, has been appointed Dean of the College of Agriculture of West Virginia University, at Morgantown, where he will have supervision of the three divisions of agricultural work of that institution, which include the resident instruction in the College of Agriculture, the work of the Agricultural Experiment Station, and that of the Extension Service.

Officers for the western division of the American Phytopathological Society, which met in Salt Lake City, were elected for the coming two years as follows:

President, S. M. Zeller, Oregon Agr. College, Corvallis, Oregon; vice-president, J. P. Bennett, Univ. of California, Berkeley, Cal.; secretary-treasurer, C. W. Hungeford, Univ. of Idaho, Moscow, Idaho; councilor, representing the Pacific Division, F. D. Heald, Washington State College, Pullman, Wash.

"British Basidiomycetae," a handbook of the larger British fungi by Carlton Rea, recently appeared from the Cambridge University Press. It is a book of 800 pages of text, containing no illustrations, but with keys and carefully drawn descriptions of the 2,546 species of fungi included in all groups from *Clathrus* to *Calocera*. Mr. Rea has long been active in mycology and is considered the best authority in England on the so-called higher fungi, to which the gill-fungi, polypores, and puffballs belong.

Weir reports in *Phytopathology* for April, 1923, a number of species of *Polystictus* which have been observed to attack the sapwood or heartwood of living trees; among them *P. abietinus, P. biformis, P. cinnabarinus, P. floridanus, P. hirsutus, P. lacteus, P. pargamenus, P. pinsitus,* and *P. versicolor.* Most of the species, according to Weir, are of little importance on living trees, and the same he holds to be true of *P. conchifer,* in spite of recent statements to the contrary.

Farmers' Bulletin 1058, by E. C. Stakman, is a powerful argument for the thorough eradication of all our common cultivated

barberry bushes as a protection against wheat rust. In 13 states its destruction is now required by law. The Japanese barberry, *Berberis Thunbergii,* which grows rapidly and does not harbor the rust, may be planted in the place of *Berberis vulgaris.* It is a small shrub, with entire leaves and with berries in ones or twos instead of in bunches. Our native barberry, *Berberis canadensis,* which is fortunately confined to only a few regions, is also dangerous to wheat and should be eradicated along with the European species.

Mrs. Flora W. Patterson retired from active service in the Bureau of Plant Industry at Washington on April 20, 1923, and Dr. C. L. Shear was designated to fill her position as mycologist in connection with the work of the Plant Disease Survey. Dr. Shear sailed for Europe on May 5 to attend the Pasteur Centennial Celebration, the International Agricultural Congress, and the International Phytopathological Conference. He also expects to purchase specimens of fungi for the mycological herbarium in Washington, and to make a study of *Phomopsis Pseudotsugae,* both in the field and in herbaria. He will probably remain in Europe until the latter part of August.

A bulletin by Ray Nelson on mosaic diseases, of great importance and significance, appeared in March as Technical Bulletin 58 of the Michigan Agricultural Experiment Station. The following statements appear in the author's summary:

" Using modern cytological methods, protozoan killing and fixing solutions and protozoan stains, an intensive study has been made of bean mosaic, clover mosaic, tomato mosaic and potato leaf-roll. Definite protozoan organisms, located mainly in the sieve tubes and sieve parenchyma, have been demonstrated to be constantly associated with these diseases.

" The bean and clover organism is a biflagellate, elongated protozoan whose generic position is near Leptomonas. It apparently is a flagellate of new generic rank, since the location and attachment of the flagella differ from the structure in any known genus.

" The organisms found in mosaic tomato plants apparently are

trypanosomes, or are closely related to this genus. They have been found only in the sieve tubes. Their size varies from 6 to 30 microns in length and from 0.5 to 6 microns in width.

"In the sieve tubes of potato leaf-roll plants, organisms have been found which more closely resemble trypanosomes than any other form. They are usually closely associated with the host-cell nucleus. These organisms are also variable in size, some individuals being less than 1 micron wide and 12 long, while the longest one measured was 35 microns.

"All of these organisms lie in a plane parallel to the long axis of the cell and have been demonstrated only in longitudinal sections."

Mr. H. C. Beardslee wrote me from Perry, Ohio, on July 30, 1922, and enclosed some observations on two species of gill-fungi which will be interesting to mycologists:

"*Agaricus distans* grows here, and is at times quite abundant. I find it in a cool ravine near Cleveland, especially late in the fall. My plants in the young stage are brightly colored and are one of our most beautiful agarics. In this stage the color is exactly as Overholts gives it for his plants. The older plants were often duller, lacking the bright colors of the young plant entirely. My observations seem to indicate that the variety is not of much valûe.

"I have *S. umbonatescens* from this region also. I am interested in one matter in regard to this that does not seem to have been commonly noted. I found at Asheville a plant which seems in some ways different. In general appearance it was much like Peck's species, but the color was not the same. It was more of an umber than a yellow. The spores were distinctly smaller and I found it invariably with a large sclerotid tuber. No one seems to mention any such tuber in our common species, and I am curious in regard to it. I am sending a photo which shows the marked appearance. I have never found *S. umbonatescens* Peck with any such tuber, and have seen no reference to such a character by any other collector. I am wondering if we have two distinct species."

He also enclosed a colored photograph of a species of *Stropharia* which he found only once at Asheville, North Carolina, the descrip-

tion of which he thought agreed fairly well with my *S. elegans*, except that it did not have a bulbous base. He was unable to get at his specimen at the time, but his photograph appears to me to agree rather with *Stropharia rugoso-annulata* than with *S. elegans*.

Dr. H. D. House, State Botanist, has just completed a valuable index of 130 typewritten pages to the 32 notebooks of Dr. C. H. Peck, covering the period from 1868 to 1913, when Dr. Peck's active botanical labors ceased. Three copies of this index were prepared, which are deposited for consultation at the State Museum in Albany, at the Division of Mycological Collections in Washington, and in the Mycological Herbarium of the New York Botanical Garden. In the preface to his index, Dr. House makes the following interesting statements:

"Investigators in mycology who have had occasion to refer to Doctor Peck's types or other collections have often commented upon the fact that his published descriptions and reports of species already published do not give the year of collection. This is explained in large part by the fact that the species described were collected during the year for which the publication is the annual report. Very rarely does he report upon any collection except of the current year, the various monographs of course excepted. These monographs were largely if not wholly a compilation of his former reports and published species, without much reference to the considerable mass of undetermined material of those groups which were stored away in bundles. This is well illustrated by Kauffman's critical study of Peck's material of the genus *Inocybe*.

"In his notebooks, Doctor Peck described under tentative names a very large number of fungi which his critical judgment did not permit him to publish for one reason or another. Without doubt many of these are valid as well as unpublished species. Since the notes were made almost without exception from fresh material they possess a considerable value to the later students of those groups. In addition, his notes upon many well known as well as little known species, made from fresh material and never published, may undoubtedly be of assistance to other investigators, and largely for this reason has the present index to his notebooks been

compiled. Investigators working at Albany may have access to these notes. Those working at a distance may secure upon application a transcript of such items as are desired. However, unless the material to which the notes refer is quite ample, it is a rule of the N. Y. State Museum not to loan material, especially type specimens."

Phytopathology for January contains abstracts of papers presented at the recent meeting of the American Phytopathological Society at Boston. The growth reactions of certain fungi to their staling products, as investigated by C. Boyle, vary with the organism and the medium used. In the case of *Fusarium* sp. and *Botrytis cinerea,* " inhibition of germination is not caused by lack of nutrient material. The toxic effect is partly due to the presence of thermolabile substances. Precipitation by alcohol deactivates some of the inhibiting factors. Filtration through collodion membrane is partly effective in restoring its germinative capacity to staled Richard's solution, indicating that some of the toxic substances present are colloidal in nature."

Foreign studies of white pine blister rust were made by Perley Spaulding during a period of eight months spent in Europe, where, except in Switzerland and Germany, *Pinus strobus* occurs rather as an ornamental than a timber tree. " The oldest *P. strobus* seen in an infected area were in Switzerland and ranged upwards to 118 years in age. Trees of this species were seen in various countries, ranging in age from 4 to 118 years, that were killed or being killed by the blister rust. There is not the slightest doubt that the largest and oldest trees can and will be killed by it." " Moir in 1920 added *Pinus koraiensis* to the known white pine hosts of *Cronartium ribicola,* leaving but four species not known to be attacked. Since then *P. strobiformis* has been inoculated in the greenhouse and *P. balfouriana* has been doubtfully reported as infected in Europe. During the present studies *P. albicaulis* was found in England bearing pycnia and one aecium."

Speaking of the introduction of the white pine blister rust into the Northwest, Dr. Haven Metcalf made the following statement: " The oldest infected (1910) pine wood found at Vancouver, B. C.,

indicates that Vancouver was the place first infected. Records are clear as to importation of *Pinus strobus* from Europe to Vancouver at this time. On the other hand, it is not impossible that there were independent introductions of the disease on Ribes as well as pine at other points, both in British Columbia and in Washington. Both hosts were introduced independently at many places before quarantines were in effect in either the United States or Canada, and it would be strange if some of these introductions were not diseased. The disease now extends north (on pines and Ribes) to the limits of *Pinus monticola,* east (on pines and Ribes) to Beaton, B. C., and south (on Ribes) to within 25 miles of the Columbia River at the coast, thus occurring within a triangle of country 425, 320, and 315 miles on a side. The heaviest spread has been northward, due to climatic conditions and greater abundance of cultivated black currant in British Columbia. Serious local damage to *Pinus monticola* has already occurred. This host appears to be somewhat more susceptible than *P. strobus,* but aside from this fact the disease apparently behaves much as in the East."

The Melanconis disease of the butternut, according to Dr. A. H. Graves, " is characterized in its first stages by the appearance of dead limbs besprinkled with small black acervuli of the causal fungus, *Melanconis juglandis* (E. & E.) comb. nov. Occasionally the acervuli develop spore horns, but are usually rounded or wart-like, and in wet weather like drops of thick ink. This conidial stage has been known as *Melanconium oblongum* Berk. The ascospore stage, which may appear late near these same pustules, has been known as *Diaporthe juglandis* E. & E., but by culture work this is now definitely proved to be the perfect stage of *Melanconium oblongum* Berk. Inoculation experiments, extending over a period of more than four years, have conclusively demonstrated that the fungus is a weak parasite. Entering usually through small twigs by way of a wound, the mycelium grows slowly down through the wood—faster if the tree is already weakened—to the main branch and finally to the trunk. Ordinarily the progress of the disease is so slow that the leaves fall one by one, not producing any striking wilting or blighting effects. In final stages affected trees have a marked stag-headed aspect. Diseased branches should

be pruned off promptly some distance below apparent infection and the wounds tarred over or painted. After the fungus has penetrated the trunk no remedy is practicable."

The camphor disease of Florida was partly cleared up by Mr. N. O. Howard, who attributed it primarily to a species of thrips, *Cryptothrips floridensis*. "Certain camphor growers, however," according to Mr. Howard, "regard the thrips injury as merely incidental to the attacks of a fungus, the latter being the really destructive organism. An undescribed species of Pestalozzia was found to be quite constantly associated with the thrips injury. Moreover, evidence was obtained indicating that the thrips is partly responsible for dissemination of the Pestalozzia spores. Inoculation experiments, however, conducted in the greenhouse upon camphor plants entirely free from thrips indicate that, under these conditions at least, this *Pestalozzia* sp. is unable to attack the healthy tissue, but develops readily in dead portions of the host. It appears, then, that this fungus is a saprophyte or, at the most, a weak wound-parasite upon *Cinnamomum camphora* Nees & Eberm. and that control of the disease lies in the elimination of *Cryptothrips floridensis* Watson."